Summary: P271 #1-5; 6-16

P271

1) The coefficients in a balanced chemical equations can be interpreted in two different ways:
(a) they are the mole ratios by which the chemicals react
(b) they are the particle ratios by which the chemical react
Both are valid interpretations, as they both deal with number of particles reacting. However, each has a different consequence on the acceptable values for the coefficients. In the case of (a), any values, including fractional values, are allowed as coefficients, as they deal with moles, which are of course huge numbers of particles. In the case of (b), fractional coefficients are not allowed, as there is no such thing as a fraction of a particle reacting in a chemical or physical reaction.

2) A balanced chemical equations shows the mole ratios by which chemicals react. Stoichiometric calculations rely on the fact of knowing the ratios of particles by which chemicals react.

3) It would not be necessary to determine a limiting reactant when one is told in advance that one of the reactants is present in sufficient or excess amounts. By default, the reactant left would be the one that is limiting.

4) The concept of percentage yield was introduced to represent the reality of what actually goes on in chemical reactions. In any reaction, products are never produced in stoichiometric amounts. This is caused by two main reasons:
(a) chemicals used are never 100% pure. Current manufacturing techniques are not capable of 100% purity.
(b) when chemicals are mixed, it is possible that more than one kind of chemical reaction can occur. These other reactions, often called ‘side reactions’, usually occur in small amounts, but will consume some of the reactants, thereby lowering the amount of predicted product(s) that can be produced.

5) The student’s reasoning is NOT correct. The student is using the coefficients in the balanced chemical reaction as mass ratios, NOT mole ratios. The correct statement would be: 4 mol of Al will react with 3 mol of O_2 to produce 2 mol of Al_2O_3.

6)

	$4Al$	$3O_2$	$2Al_2O_3$
m (g)		9.60	
M (g/mol)		32.00	
n (mol)	0.400	0.300	
ratio		3/4	

7)

	Ca	Cl_2	$CaCl_2$
m (g)	5.3		
N (particles)			7.8×10^{22}
M (g/mol)	40.08		
n (mol)	0.13		0.13
ratio			1/1

8)

	C_3H_8	$5O_2$	$3CO_2$	$4H_2O$
m (g)	97.5		292	
M (g/mol)	44.11		44.01	
n (mol)	2.21		6.63	
ratio			3/1	

9)

	Zn	S	ZnS
m (g)	6.00	3.35	8.95
M (g/mol)	65.38	32.07	97.45
n (mol)	0.0918	0.104	a) Zn: 0.0918 S: 0.104
ratio Zn			1/1
ratio S			1/1

c) Since Zn and S react in a 1:1 mole ration n(S leftover) = 0.104 mol - 0.0918 mol = 0.0122 mol
m (S) = 0.0122 mol X 32.07 g/mol = 0.391 g

10) Note that the equation is not properly balanced in the textbook; however, it won't affect calculations.

	$TiCl_4$	$2H_2O$	TiO_2	4HCl
m (g)	85.6		36.0	
M (g/mol)	189.70		79.90	
n (mol)	0.451		0.451	
ratio			1/1	

11)
Since you are given specific amounts of more than one reactant, this is a limiting reactant question. Choose Ag_2S as the target product

	4Ag	$2H_2S$	O_2	$2Ag_2S$	$2H_2O$
m (g)	1.90	0.280	0.160	2.03	
M (g/mol)	107.87	34.09	32.00	247.81	
n (mol)	0.0176	0.00821	0.00500	Ag: 0.00880 H_2S: 0.00821 O_2: 0.0100	
ratio Ag				2/4	
ratio H_2S				2/2	
ratio O_2				2/1	

12)
Since you are given specific amounts of more than one reactant, this is a limiting reactant question. Choose $CaSiO_3$ as the target product

	$2Ca_3(PO_4)_2$	$6SiO_2$	10C	P_4	$6CaSiO_3$	10CO
m (g)	20.8	13.3	3.90		22.7	
M (g/mol)	310.18	60.09	12.01		116.17	
n (mol)	0.0671	0.221	0.325		$Ca_3(PO_4)_2$: 0.201 SiO_2: 0.221 C: 0.195	
ratio $Ca_3(PO_4)_2$					6/2	
ratio SiO_2					6/6	
ratio C					6/10	

13)
Since you are given specific amounts of more than one reactant, this is a limiting reactant question. Choose H_3AsO_4 as the target product.
(In the interest of space, the products Na_2SO_4 and NO will be omitted from the table)

	$3As_2S_3$	$4H_2O$	$10HNO_3$	$18NaNO_3$	$6H_3AsO_4$
m (g)	1.56	0.140	1.23	3.50	
M (g/mol)					
n (mol)					
ratio As_2S_3					
ratio H_2O					
ratio HNO_3					
ratio $NaNO_3$					

14)

	C_5H_{12}	$8O_2$	$5CO_2$	$6H_2O$
m (g)	285	3.00	2.58	
M (g/mol)	72.17	32.00	44.01	
n (mol)	3.95	0.0938	C_5H_{12}: 19.75 O_2: 0.0586	
ratio C_5H_{12}			5/1	
ratio O_2			5/8	

15) a)

	SiO_2	4HF	SiF_4	$2H_2O$
m (g)	12.2		21.1	7.32
M (g/mol)	60.09		104.09	18.02
n (mol)	0.203		0.203	0.406
ratio			1/1	2/1

b) % yield = 2.50 g ÷ 7.32 g X 100% = 34.2%
c) (see 100% data in table for part a)
m (SiF_4) = 21.1 g X 34.2% = 7.22 g

16)

	$BaCl_2$	Na_2SO_4	$BaSO_4$	2NaCl
m (g)		4.36	7.17 g	
M (g/mol)		142.05	233.40	
n (mol)		0.0307	0.0307	
ratio			1/1	

% purity ($BaCl_2$) = 2.62 g ÷ 7.17 g X 100% = 36.5%